

RADIOACTIVITY ANSWERS

2004

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(a)(i)	0 -1	² Correct numbers.		
	β/e and Beta	¹ Correct symbol and name.		
1(a)(ii)	0 0	² Correct numbers.		
	γ and Gamma	¹ Correct symbol and name.		
1(b)	${}^4_2\text{He} + {}^{234}_{90}\text{Th}$	² Correct numbers.		
	He, α , Helium, He^{2+} in equation	¹ Correct "symbol" for Helium.		
1(c)	Alpha or α	¹ Alpha or α .		
1(d)	Ionising is the ability radiation has to knock electrons out of atoms.	¹ Ionising radiation can cause atoms/air/air particles to become charged.	¹ Ionising radiation can knock electron out of atom causing atoms/air / air particles to become charged/ become ions.	
1(e)	A neutron can spontaneously decay into a proton and an electron.	¹ neutron splits up forming electron.	¹ neutron splits up forming electron and proton.	
1(f)	Alpha particles would have ionised atoms in the jar, grabbed the electrons and changed into a helium atom.	¹ Alpha particles are Helium nuclei/ Helium ions/ He^{2+} / have same atomic and mass number as Helium (but without the electrons).	¹ Alpha particles are Helium nuclei/ Helium ions/ He^{2+} / have same atomic and mass number as Helium and Alpha particles gained electrons and became helium atoms.	¹ Alpha particles are Helium nuclei/ Helium ions/ He^{2+} / have same atomic and mass number as Helium and Alpha particles gained electrons and became helium and Alpha particles became helium atoms by gaining electrons from (ionising) other atoms in the jar.

1(g)	<p>Mass number decreases by four. Atomic number decreases by two. Must be an alpha particle and a gamma ray.</p> ${}^{222}_{86}\text{Rn} \rightarrow {}^{218}_{84}\text{Po} + {}^4_2\alpha + \gamma$	<p>² Correct calculation of decrease in atomic no. (2) and mass no. (4) or correct equation(s) with ${}^4_2\alpha$</p> <p>Or correct equation with ${}^0_0\gamma$</p> <p>(Note: Naming the emissions by themselves was insufficient for an Achieved in Criterion 2.)</p>	<p>² Correct calculation of decrease in atomic no. (2) and mass no. (4) or equation with ${}^4_2\alpha$ and γ (but no explanation/ calculation for γ).</p>	<p>² Correct calculation of decrease in atomic no. (2) and mass no. (4) or equation with ${}^4_2\alpha$ and γ and numerical calculation that explains γ / explanation why a mathematical calculation is not needed.</p>
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2005

3(a)	<p>Alpha / α Gamma / γ Beta / β</p> <p>If candidate gives Name and symbol:</p> <p>If Name correct but accompanying symbol incorrect, accept answer as correct.</p> <p>If Name incorrect but accompanying symbol correct do NOT accept answer.</p>	All correctly named.		
3(b)	Downwards particle's mass is much less than the other particle because it is an electron whereas the other particle consists of a helium nucleus (or 2 protons + 2 neutrons).	Mass is less / charge to mass ratio is greater.	Achievement <i>plus</i> reason for smaller deflection.	
4	<p>X are beta particles / β. Y is gamma radiation / γ.</p> <p>If candidate gives Name and symbol:</p> <p>If Name correct but accompanying symbol incorrect, accept answer as correct.</p> <p>If Name incorrect but accompanying symbol correct do NOT accept answer.</p>	Correct identification of both types of radioactivity.		
5	<p>$a = 1$, $b = 1$, X = proton or hydrogen.</p>	Correct values for a and b .	Achievement <i>plus</i> correct identification of X.	
6	<p>Ionisation occurs when radiation:</p> <ul style="list-style-type: none"> causes atoms to become positively or negatively charged <p>OR</p> <ul style="list-style-type: none"> electrons lost or gained from atoms <p>OR</p> <ul style="list-style-type: none"> changes atoms into ions. 	Correct answer involving radiation.		

8(a)	${}_{95}^{241}\text{Am} \rightarrow {}_2^4\alpha + {}_{93}^{237}\text{Np}$ (Americium and alpha particle must be on opposite sides of arrow) OR Equivalent equation (including numbers) showing Americium minus alpha particle goes to Np. Accept He as replacement for α .	Correct answer including Np.		
8(b)	<ul style="list-style-type: none"> Alpha particles cause more ionisation than beta or gamma because they are more massive particles. 	Alpha particles cause greater ionisation.		
	<ul style="list-style-type: none"> The range of alpha particles is much less than that of beta or gamma so an alpha source is safer to use. 	Alpha particles have a shorter range.	Achievement <i>plus</i> benefit of shorter range.	
8(c)	A long half-life means that the source would last longer / not need replacing / activity of source roughly constant.	Correct answer.		

2006

2(a)	${}_2^4\text{He}$ or ${}_2^4\alpha$ Alpha particle. Irrelevant whether numbers to left or right (but not diagonals). Don't accept: a, A.	Correct numbers and symbols OR correct particles.	Correct numbers and symbols AND correct particles.	
2(b)	${}_{-1}^0e$ or ${}_{-1}^0\beta$ Beta particle Irrelevant whether numbers to left or right (but not diagonals). Don't accept: b, B			
2(c)	${}_1^1p + {}_{-1}^0e$ Irrelevant whether numbers to left or right (but not diagonals). Don't accept: H instead of p	Correct numbers OR one correct particle.	Correct numbers AND correct particles.	
2(d)	${}_{27}^{60}\text{Co} \rightarrow {}_{28}^{60}\text{Ni} + {}_{-1}^0e + {}_0^0\gamma$ Atomic Number = 27 Mass Number = 60 Don't accept: λ , Y Accept: γ , γ	Correct Atomic and Mass numbers OR correct equation (treat zeros on gamma as neutral and numbers on Cobalt in equation as neutral).	Correct Atomic and Mass numbers AND correct equation (treat zeros on gamma as neutral and numbers on Cobalt in equation as neutral).	
3(a)	<i>Red source emits gamma rays.</i> 1. Gamma rays are very penetrating 2. Gamma rays have no charge , so are not deflected	Three sources correct. AND at least 2 of explanations correct	Three sources correct. AND at least 4 of explanations correct	Three sources correct. AND ALL 6 of

	by a magnetic field.			explanations correct
3(b)	<p><i>Blue source emits alpha particles.</i></p> <ol style="list-style-type: none"> Alpha particles are easily absorbed/don't penetrate paper Alpha particles are charged, so they are deflected by a magnetic field. 			
3(c)	<p><i>Green source emits beta particles.</i></p> <ol style="list-style-type: none"> Beta particles penetrate paper Beta particles are charged so they are deflected by magnetic fields. 			

2007

TWO (a)	<p>Different number of neutrons / 3 more neutrons in Pt-195 / 3 less neutrons in Pt-192 / different mass number / Pt-195 has greater mass. (They have the same number of protons.)</p>	One correct difference (don't accept nucleons).		
(b)	<p>The 78 represents the atomic number / number of protons. The 195 represents the mass number / number of nucleons / number of protons and neutrons / relative atomic mass (not "atomic mass").</p>	Both identified correctly (don't accept number of electron instead of protons).		
(c)	<p>${}_{77}^{192}\text{Ir} \rightarrow {}_{78}^{192}\text{Pt} + {}_{-1}^0\text{e}$ Particle is Beta particle / β or electron e^-</p>	<p>Correct equation – accept β instead of e (If γ as well, ignore. Irrelevant whether numbers to left or right – but not diagonals).</p> <p>OR Beta particle / electron produced (must be stated not inferred from equation). Don't accept: b, B.</p>	<p>Correct equation – accept β instead of e (If γ as well, ignore. Irrelevant whether numbers to left or right – but not diagonals).</p> <p>AND Beta particle / electron produced (must be stated not inferred from equation). Don't accept: b, B.</p>	
(d)	<p>Conservation of mass / mass number / nucleon number. AND Conservation of atomic number / charge number / charge.</p>	Both correct.		
(e)	<p>Half life should be long enough in order for the doctors to be able scan the patients (assuming being used as tracer). Half life should not be too long in the patient as radioactivity could harm the patient.</p>	One correct reason.	Both correct reasons.	

(f)	Alpha particles are highly ionising and could harm cells in the human body. Gamma radiation has very low ionising ability and hence is safer for use.	Alpha particles are highly ionising . OR Gamma rays are poor ionisers (do not accept gamma rays do NOT ionise).	Alpha particles are highly ionising as compared with gamma rays. AND human cells could be harmed by ionisation / cause cancer.	
(g)	<p>(i) For alpha decay, the atomic number reduces by 2 and the mass number reduces by 4. An alpha particle consists of two neutrons and two protons.</p> <p>(ii) For beta decay, the atomic number increases by one, but the mass number remains the same. A beta particle is a fast-moving electron. It is emitted when a neutron changes to a proton and an electron.</p>	<p>ONE of THREE from: For alpha decay, the atomic number reduces by 2 and the mass number reduces by 4. OR For beta decay, the atomic number increases by one, but the mass number remains the same. OR ONE of: (During beta decay, a beta particle is emitted when a neutron changes to a proton and an electron / beta particle. OR An alpha particle is emitted consisting of two neutrons and two protons.)</p>	<p>TWO of THREE from: For alpha decay, the atomic number reduces by 2 and the mass number reduces by 4. OR For beta decay, the atomic number increases by one, but the mass number remains the same. OR ONE of: (During beta decay, a beta particle is emitted when a neutron changes to a proton and an electron / beta particle. OR An alpha particle is emitted consisting of two neutrons and two protons.)</p>	<p>THREE of THREE from: For alpha decay, the atomic number reduces by 2 and the mass number reduces by 4. AND For beta decay, the atomic number increases by one, but the mass number remains the same. AND ONE of: (During beta decay, a beta particle is emitted when a neutron changes to a proton and an electron / beta particle. OR An alpha particle is emitted consisting of two neutrons and two protons.)</p>